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ROLE OF SMALL-SCALE BUILDING MATERIALS INDUSTRIES IN THE IMPLEMENTATION OF HUMAN SETTLEMENTS DEVELOPMENT PROGRAMMES AND RURAL DEVELOPMENT PROJECTS IN THE AFRICAN REGION

I. INTRODUCTION

1. The key to successful human settlements development programmes in both the urban and rural areas is the construction of appropriate infrastructure especially decent and durable housing. In fact, a considerable portion of the investments goes into infrastructure. Therefore, what is crucial to such projects is the availability of good quality and cheap building materials. This is particularly relevant in the African region where there has been a sharp decline in building activity over the past few years because of the increasingly high costs of the materials used and the strain that they put on foreign exchange.

2. Indeed, in actual practice most of the countries of the region import the bulk of the materials that they use such as cement, iron, metal sheets and plaster. The use of imported materials became an acquired habit in both the formal sector such as government contracts and the informal sector, i.e., individuals building on their own account, during the period when the economic situation still allowed it. For example, the United Nations Industrial Development Organization (UNIDO) indicates that Egypt's cement imports increased from 700,000 tons in 1970 to 7.9 million tons in 1976.

3. For major construction such imports are justified by the standards demanded by the clients. Individual builders firmly believe that only imported materials can guarantee solid buildings.

4. It is obvious that due to the current indebtedness of African countries, builders who use imported materials are finding it increasingly difficult to maintain their level of activities.

5. In some countries the materials are locally produced in capital intensive factories which are understandably not many and which always require imported components such as machines, fuel and spare parts. This results in high costs that local investors find it difficult to bear. Whether materials are locally produced or imported, the problem is the same since factories are dependent on foreign exchange for maintenance purposes and for some of their inputs. Very often, the operation of factories are interrupted because of such problems and this results in periodic shortages which inconvenience their clients. Supplies are thus very unreliable and considerably hamper the development of the sector.

6. Moreover, the factories are often located near major urban centres and therefore cannot serve rural users who are scattered throughout the country; transport costs become prohibitive for the average individual in addition to possible logistical problems. Such factories can never contribute to rural development except in the case of special State-financed projects which are few in number because of their cost.

7. Yet, given the housing shortage facing the African region which is becoming worse as the years go by because of the very high population growth rate of 2.4 per cent, solutions must be found to this problem. However, before proposing any solutions, the characteristics of the building materials market need to be defined.

II. THE BUILDING MATERIALS MARKET IN AFRICA

8. According to a UNIDO study, over the past decade, the consumption of building materials increased steadily in developing countries from $US 40.5 billion in 1975 to $US 75.5 billion in 1985. Such a trend is normal in view of the population explosion in developing countries. The study estimates that the proportion spent on the construction of housing is between 30 and 50 per cent depending on the countries. There are generally two types of building materials market, the formal market and the informal market.

(a) Characteristics of the formal market

9. This sector comprises all government contracts which are the largest as well as private or semi-private clients who use contractors for building work. Such work covers mainly communal buildings such as schools, offices and hospitals and much less housing. Work is contracted out on the basis of invitations to tender which must include technical projects and contract documents.

10. The formal market has two characteristics:

Very restrictive standards that are often inherited from industrialized countries. Funding agencies always demand the application of such standards because of the 10-year guarantee required by regulations in force. Application of such standards has two very important consequences:

- costly building methods such as reinforced concrete are used;
- sophisticated materials such as cement or lime which are the only materials that can meet such standards are used.

11. Under current economic conditions, such materials are becoming increasingly expensive particularly in terms of foreign exchange. The result is increasingly high investment costs. Also for foreign exchange reasons, large production plants are finding it increasingly difficult to operate because they depend on imported inputs for their day-to-day maintenance; hence, supplies are erratic and there are occasional shortages which considerably hamper work and delay the development of such programmes. Moreover, projects are mainly concentrated in major urban centres, i.e., near large production plants. Indeed, because of problems of transport and logistics, such types of projects cannot be established in areas with very little urbanization. When such projects are implemented in rural areas contractors are often asked to produce their own materials. They often turn to local craftsmen who produce the basic materials such as bricks under their supervision. However, sophisticated materials such as cement, iron rods and corrugated sheets are still imported.

(b) Individuals' attraction for imported materials

12. Often, the work of the formal sector is used as a model by individuals building on their own account who feel they must use the same materials, i.e., cement, concrete, galvanized sheets because they feel such materials guarantee quality. They do not want to use local materials such as tiles, lime produced by artisans, stones or wood. Yet, even if individuals can make financial sacrifices to purchase such materials, the strain on the country's balance of payments is unbearable.

13. In conclusion, it is obvious that current habits with respect to construction do not favour the development of human settlements particularly in the rural areas because the costs of the materials used are prohibitive and because it will become increasingly difficult to secure supplies because of the reasons mentioned above.

14. Governments should therefore take steps to promote the production of quality materials and encourage their use through construction programmes.

(b) Characteristics of the informal market

15. The informal market involves all those who build on their own account which is the case of the majority of the rural population. The price factor is crucial here and quality is completely incidental.

16. Seldom do people on this market buy supplies from large industrial plants. Builders have two possibilities:

- either producing the materials they require by using local raw materials such as clay to make burnt or adobe bricks, laterite for binders and thatch for roofing;

- or turn to craftsmen who work under roughly identical conditions, i.e., on the basis of techniques handed down from generation to generation.

17. The production of artisans has two major advantages:

- artisans set up wherever there are raw materials and therefore do not have any particular establishment constraints and can move around as they wish. This solves the transport problem since materials can be produced where they are used provided the raw materials are available which is often the case;

- cottage industries require very little investment and consequently costs are very much lower than costs of large production plants.

18. Unfortunately, it has several drawbacks which adversely affect the sector's development:

- Production quality is generally poor because of inappropriate methods of work. Quality is assessed using empirical rules (colour, sound and density) which are not tested in the laboratory. Moreover, since there are no serious studies on the nature of the raw materials used, the final quality of products produced by the same artisan varies very considerably. Of course, no particular standard is met;

- Inappropriate methods of work consume considerable energy. Since the usual source of energy is fire wood, it has an adverse impact on the environment;

- Often, production has no relationship to market demand: the volume of production over a given period of time is determined arbitrarily with the consequences that this might have on the quality of products.

19. As things stand now, using craftsmen is not a satisfactory option for human settlements development programmes in Africa where a minimum of quality is required in order to ensure that the constructions are durable.

III. THE SMALL-SCALE BUILDING MATERIALS INDUSTRY IN AFRICA

(i) Characteristics

20. By definition small-scale industry involves production units that require little investment to establish. This is a considerable advantage over the large production plants since any individual entrepreneur with limited resources can establish his own production unit. This means that many small production units can be established throughout a given country depending on potential demand and the availability of raw materials on the spot. Studies show that in the Africa region, raw materials such as clay, chalk, dolomite and vegetable fibres which are the bases for such an industry are generally abundant in all the countries. In any case, producers are brought closer to users which solves the problem of transport and at the same time reduces the prices of materials.

21. Because of their size, such units are easier to manage and it is a fact that large plants often fail because of management problems. Moreover, the operation of a small unit is much more flexible and it can tailor its production capacity to the requirements of the community without itscausing any financial risks to the entrepreneur.

22. For a long time, it was believed that materials such as cement could be profitable only if they were produced in large quanitities of tens of thousands of tons per year. Experiments have demonstrated on the contrary that units producing less than 20,000 tons have been profitable.

23. Small-scale industries use simple technology which has been developed by research centres specializing in building materials for developing countries.

24. First of all, such technologies use simple equipment such as brick presses or village kilnsthat are easy to maintain. The equipment can usually be manufactured locally and is generally cheap hence the little investment required to establish production units. There is therefore no problem of foreign exchange and the fact that the equipment is easy to maintain is a guarantee that it will operate regularly.

25. Secondly, such technologies use mainly raw materials that are available locally such as clay, chalk and vegetable fibres. In principle, such raw materials are abundant in the region and there is no problem of supplies.

The establishment of units depends not only on potential users but also on the availability of raw materials. This results in smaller production costs since the raw materials are generally cheap. Such technologies are tailored to the materials used and consequently yield products of good and consistent quality. This is definitly an advantage over traditional craftsmanship. Thus, small-scale industries are able to produce materials of satisfactory quality under the same conditions as traditional crafts industries, i.e., at low prices and in the areas where they are expected to be used and can thus play a very important role in reviving human settlements development programmes particularly in the rural areas.

(ii) Other advantages

26. Although small-scale industries require little investments to set up they use considerable manpower when compared to the larger plants producing the same output. It therefore generates jobs particularly in the rural areas; this is a very important aspect since employment is one of the crucial problems of developing countries. By creating jobs, small-scale industries increase the chances of success of human settlements particularly in rural areas. Special emphasis is put on the role of women since the tasks involved in the production of building materials are not incompatible with the employment of women.

27. It is worth noting that in spite of their simplicity, the technologies used in small-scale industries have been developed after serious research which took into account all aspects of the problem especially that of energy. Greater control of the production processes minimizes energy consumption. As fire wood is usually used as a source of energy, the introduction of such technologies helps to protect the environment. Whenever possible, other sources of energy such as agricultural (rice husks) and industrial (bagasse) waste products are used. This is a considerable advantage over traditional methods of production which consume a lot of energy and have many problems in securing supplies of fuel.

(iii) Current situation

28. Although locally produced building materials are not often liked by the public, many countries have started to experiment with such technologies.

Broadly speaking, there are three types of materials: materials for walls, binders and roofing materials.

(a) Materials for walls

29. Two types of materials seem to be suitable to the countries of the region: burnt clay bricks and stabilized earth blocks.

30. Burnt clay bricks are manufactured in almost all the countries either by large-scale plants or by small labour-intensive units. Small traditional production units predominate in the Central and East African subregions (Burundi, Kenya, Lesotho, Malawi, Madagascar, Rwanda, Somalia, United Republic of Tanzania, Uganda and Zaire) while in West Africa such bricks are mainly produced by medium-sized and large industries; the largest producer is Nigeria

which has a production capacity of over 100 million bricks a year.

31. Research has focused on improving the design of kilns in order to increase fuel efficiency. This not only helps to reduce costs but also to preserve Africa's forest heritage.

32. In some countries where the felling of trees endangers forest conservation, research has focused on alternative sources of energy for the baking of bricks. Various methods have thus been developed to use such sources of energy: peat in Burundi, mixing coal with clay in Nigeria and the United Republic of Tanzania, coffee husks in Uganda and palmnut husks in Ghana.

33. Studies are ongoing on the feasibility of using waste products such as rice husks, briquettes of wood shavings and nut husks.

34. It can be stated, therefore, that currently burnt clay bricks are the most widely used local materials in the region. However, efforts should be made to propagate its use particularly in West Africa and to improve the techniques used (more efficient kilns, other sources of energy and so on).

35. Stabilized earth bricks are a novelty in the region. They are still being used experimentally: construction of 300 housing units for a sugar company in Madagascar, programme for a thousand housing units in Uganda, a World Bank project for the construction of 86 primary schools in Senegal, a project for the construction of 90 housing units in Kenya (NHC) with USAID assistance.

36. The results of these experiments appear to show that the technology is well developed and could now be used commercially. Stabilized earth blocks have several advantages over burnt clay bricks:

- They do not require baking and this solves the problem of fuel which is crucial in the production of burnt clay bricks;

- They can be produced anywhere while clay is absolutely essential for burnt bricks hence the growing interest of builders in stabilized earth blocks.

37. However, both the properties of the soil and the optimal amount of stabilizing agent should be accurately determined. Lime or cement and sometimes chemicals developed by some specialized laboratories are used as stabilizer; this is why testing laboratories are needed. It should, however, be noted that considerable work has been done by research centres in this field and that even if there are currently no standards for stabilizing agents, recommendations and guidelines have been made and established in some countries such as Cote d'Ivoire and Togo.

38. The main item of production equipment is the press. Today, there are many manual or automatic models on the market. The equipment has been well developed and the most simple models can be constructed locally.

39. Today, therefore, there are no obstacles to the propagation of this building material; what is needed is simply to develop research on the amount of stabilizing agent required, depending on the soils used, and to establish appropriate standards on the utilization of stabilizing agents. Research should also be done on developing protective coatings because some experiments have showed that stabilized soil bricks are less resistent to weather changes than burnt clay bricks. Finally, publicity campaigns are essential to convince the public to accept stabilized soil bricks.

(b) Binders

40. Binders are materials that are used to join bricks or blocks in the building walls. Because cement is used throughout the entire region, some countries have come up with the idea of establishing small-scale cement production plants. Although experience has demonstrated that the idea is feasible, there are no plans to establish such plants everywhere because of technical constraints. The idea has therefore been mooted of developing other materials especially lime and pozzolana which can be found in large quantities in many areas.

41. Lime which was already used in construction in some countries has been literally ousted by cement; it is therefore little used today. Yet it has been demonstrated that where limestone and dolomite deposits are found the small-scale production of lime is perfectly possible. Lime can be used as a stabilizing agent in stabilized soil blocks, and particularly as a binder and lime wash.

42. Considerable research work has been done in specialized laboratories to determine the properties of limestone and to develop efficient burning methods such as vertical shaft kilns.

43. Small-scale production plants have been established in Madagascar and Togo by local entrepreneurs in collaboration with research centres. The results are very encouraging and should help to reintroduce lime into the construction industry as an alternative binder to portland cement.

44. Pozzolanas contain constituents which at ordinary temperatures will combine with lime and water to form compounds with cementitious properties.

45. Pozzolana may be natural (volcanic rock) or artificial. Artificial pozzolana may be made from inorganic compounds, i.e., calcinated rocks such as calcined clay, calcined bauxite or fly ash or from organic compounds such as the ashes obtained from the controlled burning of rice husk, coffee husk or groundnut husk or simply from bagasse.

46. Pozzolanas are still little used as binders in the region. They are considerably used in cement factories in Ethiopia, Cameroon, Rwanda and Burundi as supplements to obtain pozzolana cement.

47. Intensive research has been carried out by research centres throughout the world on lime and pozzolana mixtures but so far there has hardly been any practical application in the field. The results of the various studies show that the use of lime-pozzolana mixtures may save up to 40 per cent of cement for inferior quality concrete.

48. In the current situation, efforts can already be made to popularize the use of lime as a binder and research on developing pozzolana as a binder should be continued in order to use it in areas where there are abundant deposits of pozzolana.

(c) Roofing materials

49. Galvanized iron and corrugated asbestos sheets are the most widely used roofing materials in the region. Since they are imported products they are expensive and low-income earners cannot afford them. The public's passion for such materials stems from the fact that they are solid and modern. Even in the countries where local materials such as burnt clay tiles were used traditionally, iron sheets have now replaced them. Since then, a number of materials have been developed by research centres to replace iron and corrugated asbestos sheets.

50. First of all, burnt clay tiles deserve to be rehabilitated particularly in countries such as Madagascar and Rwanda where the technology for making them has already been mastered. The main disadvantage of burnt clay tiles is that they seldom last longer than 10 years. Efforts therefore be made to improve the production processes. As in the case of burnt clay bricks, the refinements developed by research centres should be used to improve the production of burnt clay tiles. The second materials on which research and experiments have been carried out is the asbestos cement tile. The fibers used to produce it are vegetable fibers, usually sisal. However, coconut fibers can also be used.

51. The results are very encouraging although the long term behaviour of these materials is not yet known. Production units have already been established in several countries including Kenya, Nigeria, Madagascar and Malawi.

52. The main item of production is the vibrating table because the quality of the product depends on the intensity of vibration. The tables may be electric powered - this raises the problem of energy in non-urban areas or they may be manually operated. However, the efficiency of manually operated tables has yet to be proved.

Summary

53. The materials presented here are not the only ones that currently exist; there are others such as stone, wood, thatch which are often used in the region. Those reviewed are the ones that can be produced by small-scale industries. The table below sums up their current state of development.

Material	Research and development	Use	Acceptance
Lime	Ongoing	Experimental	Beginning
Pozzolana	"	-	Nil
Burnt clay bricks	Very advanced	Intensive (commercial)	Yes
Bitudobe blocks	Ongoing	Experimental and pre-commercial	Slight
Burnt clay tiles	Finished	Commercial	Average
Asbestos cement tiles	Ongoing	Experimental	?

(d) Regional co-operation

54. In view of the scope of the housing problem in the region and of the crucial role of materials in the development of building industries, many international bodies have looked into the problem with a view to promoting the production and utilization of local materials.

55. Particular mention should be made of the United Nations Centre for Human Settlements (Habitat) which is conducting projects on the development of small-scale local building materials industries in Africa in collaboration with the Commonwealth Science Council. Shelter Afrique, an intergovernmental low-cost housing financing institution is more concerned with the mechanisms for financing housing programmes; but on account of the impact of materials on such programmes, Shelter Afrique closely follows the development of local materials industries in the region. Finally, in 1987 ECA started a vast project aimed at promoting the production and use of local materials in the countries of the region. The strategy is based on attracting the interest of a large number of individual entrepreneurs in order to increase the number of production plants throughout African countries and on the acceptance by the public at large of the materials proposed.

56. To attract contractors to invest in this sector, the project envisages four types of action:

- Establishing prototype production centres which will serve as technical models. Such centres will be used to train contractors in the use of the technology and in management;

- Setting up demonstration buildings to initiate builders in the use of materials and at the same time show the public how useful it is to use local materials. Obviously, appropriate architectural studies will be carried out on the models in order to adapt them to the region and facilitate acceptance by the public;

- Carrying out a contractor's training campaign aimed at training contractors in the use of production technology and in the rediments of managing such plants;

- Encouraging and assisting governments to establish policies geared to promoting local building materials which would include establishing standards, using local materials in government building programmes and allocating resources for local building materials development.

57. A major publicity campaign will be launched to present the materials that can be locally produced to the public at large; all the media -exhibitions, television, radio, newspapers - will be used. The project, which is due to go into its implementation phase at the beginning of 1989, covers countries and will last approximately four years. It should lead to the popularization of local materials in the region and an increase in the number of production centres and yield all the expected consequences, i.e., revival of construction activities, better housing conditions, creation of jobs particularly in the rural areas and, finally, making the sector free of import-related constraints.

IV. CONCLUSION

58. In view of the problems that are facing human settlements and rural development programmes in the African region today, small-scale building materials industries might appear to be ways of reviving such programmes.

59. Small-scale building materials industries are capable of producing products that are of better quality than those produced by craftsmen at comparable prices. Because of the low investments required to set up such industries, it is expected that many of them can be established throughout a given country thus bringing producers closer to users and resulting in a considerable drop in the production costs of materials. As such industries use mainly raw materials that are available locally they are free from balance-of-payments contraints.

60. It should also be noted that the processes used minimize the consumption of energy and thus have a favourable impact on the ecological environment. Finally, small-scale industries are highly labour-intensive and their establishment will certainly have a favourable impact on employment especially in the rural areas.

61. However, as things stand now, these materials have not yet been accepted by the public. Consequently, considerable efforts have to be made to promote their use. Governments have a very important role to play by creating a favourable climate for the promotion of such materials, i.e., revising standards, establishing sources of financing and training programmes, providing support to research and development agencies and reflecting the needs of the sector in their development policies. Finally, governments should above all give an example by using such materials as a matter of priority in their projects. Experiences of some countries have demonstrated that the public is very sensitive to state action in this field.

BIBLIOGRAPHY

1. Dolphin N.: Review of low cost equipment for small-scale Manufacture of local Building Materials in Africa (ECA 1988)

2. ECA: Etat d'avancement de la mise au point des matériaux de construction locaux en Afrique (Working paper, Addis Abèba, 1988)

3. Sethuraman, S.V.: Basic needs and the informal sector: The case of low-income housing in developing countries, ILO World Employment Programme Research Working Paper (Geneva 1985)

4. Stulz R. : Appropriate Building Materials, Intermediate Technology Publications Ltd. (Worcester, 1986)

5. UNCHS/HABITAT: The use of selected indigeneous building materials with potential for wide application in developing countries (Nairobi, 1985)

6. UNCHS/HABITAT : Development of the construction industry for low income shelter and infrastructure (Nairobi 1988)

7. UN Commission on Human Settlements: Global strategy to the year 2000; Report to the Executive Director (1988)

8. Wells J.: Acellevoked Dissemination of fibre concrete tile technology in Kenya (March 1988)

9. Wells J. : Intermediate Building Technologies: Barriers to their introduction in institutional Building Programmes. ILO Report, 1987)